

DIRECTIONS

FOR

GENTLEMEN,

WHO HAVE

Electrical Machines,

How TO PROCEED IN MAKING THEIR

EXPERIMENTS.

Illustrated with CUTS.

By JOHN NEA

With a compleat Series of EXPERIMENTS,
and the Management of them, as shewn in
his Course.

L O N D O N,

Printed for the Author, in the Year M D C C X X I.

(Price One Shilling and Six-pence.)

DIRECTIONS

FOR

GENTLEMEN,

WHO HAVE

Electrical Machines;

HOW TO PROCEED IN MAKING THEIR

EXPERIMENTS.

UNIVERSITY
LIBRARY
CAMBRIDGE

JOHN NEALE, Esq.
Street, London: C.

With a complete Series of EXPERIMENTS,
and the Management of them, as shown in
his Course.

015...56

LONDON:

Printed for the Author, in the Strand near
(Face containing the title-page.)

(3)

DIRECTIONS FOR GENTLEMEN

WHO HAVE

Electrical Apparatus's, &c.

MY main intention being to direct such private persons as are provided of an electrical machine and a requisite apparatus, how to put them in order, and perform with them, the experiments usually exhibited in publick; I shall not take up my reader's time with enquiring into, or defining what electricity is, or how long it has been known in the world; nor shall I go about to enumerate its several laws and properties, otherwise

otherwise than occasionally; since there is great reason to imagine we are hitherto acquainted but with few of them, in comparison of what would be necessary for inferring any thing general about it, or its uses in the œconomy of nature.

When the machine is to be used, the globe or spheroid should be first wiped clean with a dry warm linnen cloth, its pivots oil'd, and the string duly stretched on the wheel. The rubber, or cushion should be likewise warm'd at the fire, but not so much as to bring out any greasiness to the surface of the leather; and if the weather be damp, or pretty cold, it will be necessary to have a fire in the room not far from the machine.

If the globe be excited by hands, without, or in conjunction with a rubber; the hands should be rubb'd over
with

with dry whiteing, as also the rubber, if its leather covering be not intirely free from all greasiness; which it seldom is after it has been any time in use.

In order to proceed commodiously with the intended experiments, some metalline body must be brought nearly in contact with the glass globe, to receive immediately the electrical matter from it, and conduct it to other un-electrify'd bodies: This for distinction sake I shall call the *prime conductor*, And it's absolutely necessary, that such prime conductor; as well as the non-electrics it is to electrify, should be suspended on, supported, or terminated by natural or original electrics, otherwise call'd electrics *per se*; such as silk, glass, rosins, and sulphurs, which will not permit the electric matter to pass thro' them to other bodies, and so at last be lost in the ground.

The

The thing most usually employ'd as a prime conductor, is either a gun-barrel, or a tin-tube, suspended on lines of blue silk: And it may be convenient to place it horizontally about 6 feet high, so that persons may pass at freedom under it; and from one end thereof, which should be just over the equatoreal part of the globe, let 8 or 10 small wires descend to within a quarter of an inch of its surface, and be all in a plane passing thro' its axis, about a third of an inch asunder: For wires so pointed to the globe, have been experienced to receive and convey the virtue much better than tinsel, chains, &c. commonly used for this purpose. An iron rod suspended by silk at each end, as at A A in fig. 1. plate 1. makes a good conductor.

The supporters of the prime conductor, &c. must be very dry and
clean

clean from dust ; else the electric virtue will be wholly, or in great measure, carried off thereby ; as it also will by too near an approach of any non-electric to the globe, or to the primary or any other inferior conductor ; which should be at least 8 inches from every thing but the rubber and supporters.

Such provision being made, I now proceed to the experiments themselves, leaving other particulars of the apparatus to be described and spoken to occasionally in their proper places.

EXPERIMENT I.

A piece of swan's down tied to the extremity of a moderately fine flaxen thread about two foot long, and the other extremity held in the hand of an unelectris'd person standing on the ground, being brought near the prime conductor,

conductor, the down will be nimbly attracted by the prime conductor, and keep adhering to it, if suffer'd to touch it; the electric matter continually running off thro' the thread to the floor: And tho' the person should quit the thread, yet will the down continue to stick to the prime conductor, as to the tube B fig. 4. plate 1. and support the thread, provided it be long enough to reach so near to the ground, table, &c. as to deliver the electric matter with which it is continually charg'd, thereto, or dissipate it in the air*. But if the thread, whilst it is kept thus suspended, be cut off with a pair of scissors near the prime conductor, the down immediately drops, being replete with electricity, which it cannot now deliver off for want of the thread: For it is a known property of all electrify'd bod-

* Sometimes this will hold good at the distance of 5 or 6 feet from the ground or any non-electric.

ies or particles, to be repell'd by, or recede from one another, as also to be attracted by unelectrify'd non-electrics.

I confess I have propos'd it as a query to my self, and take leave now to do it to others; whether this seemingly odd phenomenon may not be otherways accounted for? namely from the electric virtue flying off from the extremity of the thread, as from a point, in quantity sufficient to keep the thread in a non-electric state, in part, tho' not in the whole; so that as the thread is only in part electrify'd, it is, in consequence thereof, attracted; but being not kept absolutely full of the virtue by reason of the constant emission at bottom, it cannot be repell'd.

Another thing observable which accompanies this experiment is, that when a person so holds the thread with one hand, that the attracted down approaches

B

aches very near, but does not touch the tube; if he then brings a finger of his other hand towards it, as at H, 'twill be strongly repell'd by the said finger; which seems to contradict that other known property, that electrics are always attracted by non-electrics.

But here it should be consider'd, that tho' at first sight one would grant the down in this case to be electrify'd, yet in reality it is not so; for nothing, as I said before, can be electrify'd, that is not supported or terminated by some original electric; whereas here the feather and thread are held by a non-electric person, standing on the ground; so that no electric virtue can be retain'd in them, but passes all off to the ground, or spends itself in the air almost as fast as it is supplied from the excited globe. Would it not be better, if we must render some account of this matter, to suppose, as just now, that tho' the electric

(II)

electric matter runs off to the ground, &c. yet in this near approach of the finger and the down to the tube a small quantity is accumulated in them, and so they may be each in some respect consider'd as electrify'd, and as such repel one another?

EXPERIMENT II.

If a piece of down, such as in the former experiment, be fasten'd to the extremity of a silken thread, and the other end being held in the hand, the down be brought within a moderate distance from the tube; the down will be attracted thereby, and presently after the contact be repell'd. This happens because the down, being instantly saturated with the electric matter, and having nothing annex'd to it whereby to convey it to the ground, is repell'd by the electrify'd tube, according to the known principle,

ciple, and will no more come to the conductor, 'till it has touch'd some non-electric, or lost its virtue gradually in the air.

But if the person with the other hand presents the point of a needle towards it, as at F in fig. 4. plate 1. tho' at the distance of 8 or 10 inches, it will then not be repell'd, but will cling to the tube.

I observ'd before, that metalline points apply'd to the prime conductor, receive the electric virtue from the globe better than any thing else; and in this case the needle receives it, even at the mention'd distance, from the feather, and so runs it off thro' the person that holds it, to the ground; whereby it is in a manner robb'd of it, and so, being reduced as it were to a non-electric state, is attracted by the tube.

And

And that the matter is really so drawn away to the needle's point, and, thro' him that holds it, to the ground, will thus appear: Let the person holding the needle, and pointing it, as before, stand on an electric pedestal; and let another, standing on the ground, touch any part of his body, and he will be found to snap and emit fire near as strongly as if he actually touch'd the conductor or tube with his hand,

EXPERIMENT III.

Such a piece of down as in the former Experiment, being tied to the top of a wire fix'd on the tube as at E in fig. 2. plate I. is a pretty representation of the noted sensitive plant; the production of whose extraordinary phenomena the electric virtue may probably have no small share in: For the down, as soon as it becomes electrify'd,

trify'd, will have all its fibres erected and disjoin'd from each other as much as possible ; and this from their repelling one another as electrics ; but upon the least touch of a finger, on the tube, as at K, like the leaves of the said plant, they will instantly shrink together and be clos'd up. The same thing will happen upon the approach of a pin or needle's point, as in the former experiment: And for the same cause a candle brought near it will do the like ; its imperceptible smoaky effluvia being a powerful vehicle to carry off the electric matter.

The feather so plac'd, is also of use to shew, by the erect or languid state of its fibres, to what degree the electric virtue is excited at the globe, and bestow'd on the prime conductor.

To vary this experiment a little further ; a number of these down feathers
may

may be hung to flaxen threads, and those ty'd at different distances, to a piece of wire fix'd horizontally to the end of the tube; which as soon as electrify'd, the feathers will all fly out a considerable distance from each other, and their fibres diverge, as at e e e, and 'tis pleasant to see that they will all crowd to a finger brought near them, as at P; so that 'tis impracticable to touch the wire in the most open place, without running foul of them; except a sharp point, or a candle be offer'd them, which at a great distance will drive them into a languid inactive state, as above.

EXPERIMENT IV.

The business of attraction and repulsion already spoken of, will be farther illustrated by this, and the following entertaining experiments.

Let

Let a plate be hung horizontally by wires to the prime conductor or tube, as in fig. 6. plate 2. and let common scowring sand be held in another plate in a non-electric hand, or plac'd on a pedestal 5 or 6 inches under the former; and the sand will be reciprocally attracted and repell'd, so as to resemble a stormy shower: And if the plate and sand be held under the hand of a person electrify'd on a stand, it will be attracted and repell'd as before; and the hand will feel the sensation of a strong blast of cool wind. Small bits of cork, brann, pollard, and all light non-electric substances will be in like manner alternately attracted and repell'd.

EXPERIMENT V.

Let two small bells be suspended to the prime conductor, or otherwise; so as that one of them may have communication

munication with it by means of an inferior conductor; which bell must be terminated by silk, or some electric *per se*. The other bell must be fix'd to a non-electric, and so have communication with the ground. Let them be of an equal heighth, and the nearest distance of their edges about an inch. Between them must hang a small light metalline ball or clapper, suspended by silk, rather nearer the latter than the former bell. Things thus dispos'd, and a wire of communication being extended from the prime conductor to the tail of the bell hung to silk; as soon as the globe is excited and this electrify'd, the virtue will also be communicated to the clapper almost contiguous to it; which being hung to silk, and so not able to part with the virtue, will, as an electric, be repell'd from the electrify'd bell, and at the same time attracted by the unelectric bell; which instantly absorbing its virtue

C

and

and delivering it away to the ground, it is repell'd back by it to the other; and so alternately, as long as the virtue comes from the globe: And the bright electrical fire is emitted at each contact with either bell.

If a silk string be fix'd to one of the bells, and another to the clapper, and a hook'd wire to the other bell; and all of them be hung on upon the prime conductor; there will then be no need of doing any thing, but for an un-electric person to hold a pin's point near the surface of the bell fasten'd to silk: For then, as soon as the globe moves, they will fall a ringing, as before, and stop upon taking away the pin or touching the conductor.

Also let three bells, and two clappers between them, be hung to the prime conductor, as at O. P. Q. fig. 1. plate 1. the middle bell and the two clappers by
silk,

silk, the other two by wires. From the
 midst of the inside of the middle bell
 let a small wire, ten or twelve inches
 long, descend, with a little bobb or but-
 ton at the end of it. This done, and
 the machine set to work, no motion
 at all will be produced in the clap-
 pers, unless some body lays hold of
 the button as at B plate 1. fig. 1. and
 then, the middle bell being a non-elec-
 tric that has communication with the
 ground, they instantly fall a ringing and
 emit fire, as in the case of the two above;
 and upon letting go the button they will
 cease : The same effect will be produced
 by presenting the point of a needle near
 the button or the surface of the mid-
 dle bell, and taking it away again ; and
 something seemingly wonderful may be
 perform'd by the needle in the follow-
 ing manner. Let the person who pre-
 sents the needle, as before, stand on an
 electric pedestal, and the needle will
 do nothing ; but let him command the

bells to ring, and at the same time slip one of his toes off the pedestal to the ground, and his order will be instantly obey'd: Then bidding them stop, and the company's eyes being fix'd on the bells for the event, let him replace his foot, and they cease.

EXPERIMENT VI.

There is however an experiment, which affords a proof that these two powers of attraction and repulsion may be so temper'd or constituted *in equilibrio*, as to keep a third body suspended between the electric and the non-electric. Hang a plate on the prime conductor horizontally, and hold another plate in your hand, also horizontally, on which spread a leaf of gold or silver; then, the globe being excited, hold the leaf-gold under and parallel to the suspended plate, at five or six

six inches distance, more or less, according to the strength of the electrical virtue; and instantly the leaf-gold will be erected vertically, and hang steady between the two plates without touching either, and emit fire at its upper and lower corner; but upon touching the tube, or presenting a pin or needle's point thereto, it instantly drops, crumpled all of a heap.

This experiment affords a very pretty appearance, when perform'd in the following manner: Let a metalline ball, fasten'd at the end of a wire, be placed at the end of the tube, as at *e* in fig. 3. plate 1. the gold leaf being suspended as before, may be conducted round the ball by properly moveing the plate, or by the person's own hand, as represented at A and B.

Ex-

EXPERIMENT VII.

If a glass ball of four or five inches diameter, hanging by a wire from the prime conductor, as at D in fig. 6. plate 2. and another lesser ball or bubble of $\frac{3}{4}$ inch diameter, exceeding thin, be placed upon a smooth horizontal metalline plate, as at E, and brought by the hand near the larger ball; this lesser ball or bubble will not only be attracted to the large one, but will perform continual revolutions round it; the electrical matter running off thro' the person to the ground, whereby the bubble is kept in a constant state of attraction. This circular motion has been thought by some to have a kind of analogy with that of the planets round the sun: Wherefore, to render this experiment more similar, a sort of artificial orbits may be made of metal, as fig. 5. plate 2. connected by wire staples, and called an electrical Orrery or *planetarium*.

planetarium. If to such a one three equidistant legs of sealing wax be fitted, as *b, b, b*, and it be placed on a smooth non-electric stand, fix'd on a pedestal by a ball and socket, and then, the bubble, representing a planet, be put into any of the orbits; as soon as the machine works, this planet will revolve; sometimes direct, and at others retrograde, as it happens to set out: This it will do, when the power is tolerably strong, even on a plane inclin'd several degrees to the horizon; in this respect representing the inclination of an orbit to the plane of the ecliptic; and tho' the orbit be made elliptical, yet it will move in that case too, and so represent a comet; moving much quicker in the *perihelion* than in the *aphelion*, and appear luminous in the dark. In the fig. A represents the sun *e, i, o*, three planets, which if desired may all move together.

EXPERIMENT VIII.

Hang a small metalline bucket of water on the tube, as at A in fig. 4. plate 2. and immerge a recurved glass syphon, as B, with a very small delivering orifice therein. Before the syphon is electrify'd, the jet of water will be thrown to a small distance, as at c. But as soon as the electrical virtue takes place, the particles repelling each other, will disperse, and be thrown sometimes more than a yard further. In this case the spouting water is so strongly electrify'd, as to be luminous in the dark; and a person on an electric stand, by receiving it on one of his hands, may easily fire spirits with the other.

Tho' it seems as if the electrify'd water would all run out much sooner than when unelectrify'd; yet it appears from experience, that much the same
time

time is expended in either case: For it is not the efflux at the orifice that is at all promoted by the electrical virtue, but only the particles being at freedom after they have escap'd the vessel, and still continuing in a state of electricity, do repel or recede from each other.

EXPERIMENT IX.

A loadstone being hung to the prime conductor, and a key or other piece of iron hung to the armature of the loadstone; if the finger or other non-electric be brought near the iron, it will snap and emit fire, and also will kindle warm^r spirits held under it: An unquestionable proof that both the magnetic and the electric virtues can act at the same time on the same subject, without destroying or interfering with one another.

EXPERIMENT X.

Since nothing can be electrified that is not suspended or supported by an original electric; and as a good part of the most entertaining phenomena in electrical experiments arises from electrifying human bodies, there have been various ways contriv'd to answer this end. The *Germans* frequently fasten four silken ropes to the ceiling, which at their lower ends sustain a kind of bench for the person to sit on: But here the swinging motion he is liable to is very inconvenient; for if he attempts to keep himself steady by extending his feet to the ground, he loses all his electric virtue that moment. To remedy this, they have contriv'd a square frame with four legs, and cross lines of silk stretch'd very tight for the person to stand upon. The *French* and we use a mixture of pitch and rosin
for

for this purpose: But the most commodious pedestal of all, I think, is a three corner'd board, each side about 15 inches, with a glass bottle cemented by the bottom at each corner, serving for three legs. But these must be kept as warm, at least, as the air of the room, and perfectly clean from dust, else they will convey off the virtue; with this precaution nothing exceeds them.

The person to be electrify'd, being placed on the pedestal or stand, touches the prime conductor, or lays hold of a wire or chain fasten'd thereto, but the other end may be fix'd to the pedestal, which is better; for so he will have both hands at liberty: Then, as soon as the machine is in motion he is electrify'd and emits fire upon touching any part of a non-electric person, as likewise does the non-electric upon touching him.

EXPERIMENT XI.

Let a non-electric person gently grasp the shoulders or arms of him that is electrified, and it will seem as if small pins were pricking him; the same will happen if the electrified grasps the non-electric.

EXPERIMENT XII.

If the electrified person draws his sword and extends it, a brush of blue fire will be seen to issue from the point in the dark: But let an un-electric person present the point of a needle against the sword's point though a yard from it, and the fire will instantly disappear.

Ex.

EXPERIMENT XIII.

Put a hoop or garland of leather, silver'd and lacker'd, round an electric person's head; then let one unelectris'd bring the tips of his fingers near the said hoop, moving them backwards and forwards, and brisk flashes of lightning will surround it: May not this, in Mr. *Rackstrow's* style, be call'd THE DIADEM OF BEATIFICATION?*

EXPERIMENT XIV.

Let the electris'd person hold a piece of money between his teeth, and an unelectric touch it: The jarr will be such as will probably make him drop it.

* What Mr. *Bose*, the *Wirtemberg* Professor's BEATIFICATION really is, will be shewn elsewhere.

EXPERIMENT XV.

Let a person standing on the ground offer to kiss another electrify'd on the stand, and 'tis ten to one if he executes his purpose, tho' the other be as willing as he, unless they are both appris'd of the smartness of the snapp with which each will be affected on the near approach of their lips, and resolve not to be startled at it. In order to manage this experiment properly, each person should bend a little forwards, and lean their heads towards the same shoulder (that is, each to the right or to the left) so as to prevent any other parts besides the lips coming within the sphere of their respective electrical effluvia. If a rose-bud be presented to the nose in the like manner, the sensation will be much the same.

Note,

Note, that in these and all other experiments, where persons are thus electrified on the stand, they must be careful that the bottoms of their shoes are not very wet, and that no part of their clothing touches or comes within two or three inches of any non-electric; otherwise they will lose a good part, or the whole, of the communicated electric virtue.

Having proceeded thus far, it is now time to introduce the famed condensing phial, and shew its use and applications in several extraordinary and wonderful experiments. And first I shall describe the method of preparing it in the ordinary manner, and as it was made use of here and abroad, till a gentleman among us (for which the lovers of experimental philosophy are much oblig'd to him) contriv'd a way of increasing its force to the greatest degree possible, and at the same

same time render'd it capable of conveying the effect to any distance; and that too without the least inconyency to the operator, who would otherwise be frequently liable to very painful and terrible shocks.

EXPERIMENT XVI.

Take a glass phial of any size, free from cracks, the thinner the better (for indeed it must not be thick) and having fill'd it near full with clean water, fit a cork to it; then thro' the cork pass a wire, as large as it will conveniently admit, which must reach to the bottom of the phial, or very near it: The upper part of the said wire, above the Cork, should be bent, so as to hook it to the prime conductor, as at D fig. 4. plate 2. It were better that the wire were of other metal than iron, to prevent its fouling the water by rust. The above process
being

being gone thro', the phial is fit for use; only you must be careful that the outside be very dry, and that not the least moisture escapes at the cork, which will be best secured by covering it all over with wax: And as cold glass is very apt to collect the humidity of the air on its surface, it will be proper before you use it, either to warm it at a reasonable distance from the fire, or place it some time in warm water, and then carefully dry it with a warm napkin.

EXPERIMENT XVII.

In order to electrify the phial, as 'tis commonly term'd, but more properly, to condense the electrical matter therein, hang it by its hook to the prime conductor, as at D fig. 4. plate 2. and grasp its body with one hand. When as much of the matter is accumulated as it will contain, the surcharge
E will

will be seen continually issuing out in a diverging brush of blue rays from the end of the hook, if the experiment be made in the dark ; and when this light begins to appear, 'tis a sure sign that you need continue the operation no longer. But in day-light the best way is to grasp the phial in your hand, as before, and without hanging it on, bring only the bent part of the hook so near the conductor as to produce a continual snapping ; and as soon as such snapping ceases, the phial has certainly receiv'd its full charge.

Note that in either way of charging the phial, if the body thereof has not communication with the ground, either by means of him that grasps it, or otherwise, it will be impossible to introduce into it even the least quantity of the electrical matter.

EXPERIMENT XVIII.

If the phial stands on a thick glass salver, or on a cake of pitch, rosin, or wax, when its hook is held to the prime conductor, it will not snap above once, and that very faintly; nor will it receive the least part of the electrical charge, unless the operator, or some one near him, touches or approaches the body of the phial; and in that case the electrical matter may, in the dark, be seen as fire to issue from the point of the finger, and pass thro' the glass into the water. This experiment was communicated from *Paris* to *Martin Folkes Esq;* the worthy president of the Royal Society, by *Mr. Needham*, who seems to wonder much, that *here we see an example where an electric per se is so far from terminating or excluding the power of electricity, that it is even made a medium of communication in circumstances*

cumstances where the wire, which is a non-electric per se, refuses to perform its office. But this gentleman was, it seems, unacquainted with what I have advanced in the XVIIth. experiment; that to receive the charge, the body of the phial must indispensably have a communication with the ground: whereas here that communication is interrupted by the glass salver, an electric *per se*, thro' which, at least thro' its solid pedestal, the electric virtue cannot pass, tho' it may thro' the thin phial.

EXPERIMENT XIX.

The phial being grasp'd with one hand on the prime conductor, as in the last experiment; if, when it shews the mark of being charg'd with the electric matter, he that grasps it offers to touch any part of the conductor with a finger of his other hand, a brisk flash and a smart snapp will be perceiv'd, and
he

he will feel a convulsive shock in both his elbows ; but if the phial be pretty large, and the power strong, scarce any thing will be felt in the elbows, but a kind of thump will be felt on the breast bone.

This is commonly call'd the *Leyden* experiment, where Professor *Muschenbroeck* having made it by accident more than design, it is said that gentleman was so terrify'd therewith, that he could never prevail upon himself to repeat it ; but he sent an account of it to the *Parisian* Academy, where Dr. *Le Monnier* and others made no scruple to run the hazard ; and it is now well known among us, having been communicated likewise by Mr. *Needham*.

EXPERIMENT XX.

The phial having been charg'd on the prime conductor, or by applying its hook to the revolving globe; let the person that grasps it in one hand, take it away, and offer to touch its wire with a finger of the other hand; The same snapp, flash, and shock will be perceiv'd, as in the last experiment.

EXPERIMENT XXI.

If the whole company, or any number of persons, all standing on the ground, should join hands, so as to form a kind of chain; and he that is at either extremity grasps the body of the phial hanging on the prime conductor, the person at the other end at the same time touching any part of the said conductor, they will all alike feel the same shock, as in the last experiment.

In

In the foregoing experiments, if the persons concern'd are joined by the intermediation of wires or chains, that is, a wire or chain held between each two, they will all alike feel the shock, just as when they joyn hands: But if any single person brings those ends of the wire which he holds in each hand together, so as to touch or cross one another, such person will feel nothing at all: For the electric matter will always take its course entirely thro' metal if it can, without passing thro' any animal or other body, tho' in ever so close contact with the metal.

EXPERIMENT XXII.

If a person grasps the charged phial hanging on the prime conductor, as at E fig. 4. plate 2, and at the same time brings the expanded palm of his other hand near the lower end of an Egg, as F,

F, hung also by a wire to the same conductor; that hand will be as it were suddenly attracted to the egg; a great deal of fire will issue from the egg; and if it be done in the dark, the whole body of the egg will appear full of fire, the hand at the same time feeling a smart stroke, as if given with a ferula.

EXPERIMENT XXIII.

The phial being fully charg'd, take it off from the conductor, and grasp it by the body in your right hand. Then touch the conductor with the fore finger of your left hand to clear it of all the remaining electrical virtue; which done, bring the wire hook near enough the conductor to produce a snapp, whereby the conductor becomes electrify'd again, which electrical virtue take off with a finger of your other hand as before. This operation you may repeat a great number of times, sometimes to 500 times,

times, if the phial be large, without quite exhausting it; for after all, if you touch the hook with your other hand, a loud snapp will be heard, and you will be shaken in both elbows.

One would at first be apt to suspect, that when the tube, is thus repeatedly electrify'd by the application of the hook of the phial, and the virtue as constantly taken away by the touch of the finger, that it actually returns again into the phial thro' the person's body that holds it; and the more so from the great number of repetitions it will admit of without the virtue's being quite exhausted: But that this is not fact, is plain from hence, that 'tis not necessary that the person who imparts the virtue from the phial to the conductor, should himself take it off. For another who has no contact with him or the phial may do it, and the repetition be made as often as before.

F

fore. Upon the discovery of this last particular, a suggestion arose, that by this means, if the operation were continued on till no more snapping cou'd be produc'd, the proportion of the whole electric matter condens'd at first in the phial, to that which is communicated at each single snapp from the phial to the tube, might be certainly assign'd, *to wit*, that of the whole number of the snaps to unity: But as the electric matter is all the while running out from the extremity of the crooked wire, and dissipating in the air, no such conclusion can be form'd: All that can with certainty be affirm'd is, that the total charge of a good large phial, amounts to at least 500 times as much as the conductor receives at a single snapp, from the same phial.

Ex-

EXPERIMENT XXIV.

If a person electrify'd on a stand as in Experiment X. holds a condensing phial in his hand by the hook, and the operator standing on the ground and grasping the body thereof, offers to touch any part of the electrify'd person's body; the person will feel a shock even thro' his cloths, at the place where he is touch'd, and will be jarr'd in the elbow of that hand which holds the hook.

EXPERIMENT XXV.

Let a wire of 8 or 9 inches long be thrust in between the wig and the crown of the head of the person electrify'd on the stand, and the phial being held as before, let the operator with the end of his finger touch the extremity of the wire, and the person will feel a sort of thump on his head, but without pain.

EXPERIMENT XXVI.

If a wire be tied pretty close about the naked head, and every thing order'd as in the foregoing experiment; upon the operator's touching the wire, a smart pain will be felt all round, just under the wire, as if the skin were suddenly cut thro' with a knife; on which account I call it the scalping experiment, and only mention it, without recommending the practice on persons unappris'd thereof.

EXPERIMENT XXVII.

Take a condensing phial pretty large, and nearly fill'd with very clean water: Bind close about the body of it a small wire, which should be about a yard longer than what is sufficient to surround the phial: To the loose end of this wire fasten a key, or such like piece of metal;

metal; then hanging the phial on the prime conductor, let it receive its full charge, holding the key in your right hand: This must be done in the dark, and as soon as you see the blue flame issue from the extremity of the hook, touch the conductor with the key, and at the instant of the snapp the whole body of the water will be seen fill'd with flashing streaks of bright purple light.

I come now to the before mention'd improvements of the condensing phial.

Dr. *Bevis* having observ'd, that the shock felt from the discharge of the phial was, *cæteris paribus*, in proportion to the surface of its body cover'd by the hand at the time of its explosion; rightly judg'd, that if the whole surface there of were cover'd with metalline matter, it would, tho' touch'd over so slightly

slightly with the hand, exert the utmost possible force in its discharge, which he found to be true upon trial : But finding the effect almost insupportable to the operator, he consider'd of a method to secure against this inconvenience ; Having observ'd, that when the effect was communicated thro' any metalline substance, it was insensible to a person in contact therewith, provided he did not terminate the said substance (as I have remark'd at the end of the XXIIId experiment) he thence deduc'd the remedy he sought after, and his method of proceeding is as follows.

EXPERIMENT XXVIII.

Having chosen a thin phial, fill it with the filings of iron or brass instead of water, and introduce a proper wire into it as before ; which because of the greater weight of the contents of the phial should be pretty large. This done

done let the phial be coated over with thin sheet lead, such as tea tubs from *India* are lin'd with: This covering must reach as high on the outside as the metal filings do withinside; but no higher, to prevent the phial's exploding of it self, which it will be apt to do, if this precaution be not taken; the lead must be bound on very close with wire hoops, and to the bottom part thereof must be hung a wire or chain of 3 or 4 feet in length, to the end of which a key or the like should be fastned; lastly a piece of cork of the size and shape of a small nutmeg, is to be stuck on upon the extremity of the wire hook, and then thinly cover'd over with a mixture of equal parts of resin and bees-wax to prevent the condens'd electrical matter from escaping too fast: Thus is the phial prepar'd according to the Doctor's Improvements: And if the XIX, XX, XXI, XXII, XXIII, XXV, XXVI, and XXVII. Experiments be repeated therewith,

with, the effects will be surprizingly increas'd. These which follow should always be perform'd with it.

EXPERIMENT XXIX.

Hang the coated phial on the prime conductor; and either grasping its body or laying hold of a wire fasten'd thereto, let it receive its full charge: This done, take it off the conductor, not with your hand, or any non-electric substance, but a silk loop or noose thrown over the wire hook, by which hold it suspended in the air, and with a finger of your other hand offer to touch the hook, and it will snap, but no more than once; do the like to the metal coat of the phial, and that will snap also, but, like the hook, no more than once: Now touch the hook again, and that will produce a new snapp, and so will the coat, if you touch it again; and thus you may
continue

continue the snapping by removing your finger from the hook to the coat, and *vice versa*, a great number of times. *

EXPERIMENT XXX.

If the charged phial be placed on a table, and any light body, as a small hobby-horse bell, be suspended by a fine wire, within the distance of two, three, or four inches of the body of the phial, the phial will attract that light body to it with force, if any of the company touch the hook of the phial. Mr. *Needham* also sent us this experiment; and he adds besides, that *if the phial itself be touch'd, it will repell it with a force equal to its attraction in*

* This experiment was first shewn me last winter by Mr. *Canton*, master of the academy in *Spittal-Square*; whose genius and abilities seem to promise, that this and other branches of natural philosophy may receive great advantage from his discoveries.

the first case. But I could never observe any such consequence, tho' I have made the experiment with a piece of down suspended by a fine flax thread, which, if I touch'd the wire, wou'd be attracted at more than a foot distance, and adhere to the phial, but would not discover the least mark of repulsion when I touch'd the body of the phial. The experiment will succeed as above, tho' the phial be suspended by silk.

EXPERIMENT XXXI.

We have said before, that the effect of the condensing phial, by the means of its coating, and bottom wire, might be convey'd to any distance. We will suppose it, for instance, plac'd quite out of sight, or in another room: And from the hook let a wire (no matter how small) be brought to reach the prime conductor. This wire must not in its passage any where touch any non-electric, and

and may therefore perhaps require a silk supporter or two: As for the bottom wire, that may touch any thing, and 'tis only necessary that it should come near, or within reach of the prime conductor. Let a person take the end of this wire in his hand, and then without more ado touch the prime conductor with a finger of the other hand, and he will receive a very violent shock in both elbows or on the *sternum*. If a person sits on the wire, convey'd under the covering of a cushion, and touches the conductor, tho' with a barr of iron, he will be shock'd in like manner.

Again: Let the bottom wire be convey'd under a carpet, and the whole company joining hands, direct the person at one extremity to tread on some part of the carpet, under which you know that wire passes, and then let him at the other end touch the conductor, and they will all feel the shock: This experiment

periment is call'd by Mr. *Watson*, The springing an electrical mine.

EXPERIMENT XXXII.

If the operator, when he is producing the snaps by touching a person simply electrified, on a pedestal, has a mind to give him a shock unawares; let him tread with one foot on the conceal'd bottom wire, and then touch any part of his body. But he will, in this case, receive an equal shock himself, to avoid which, if he thinks it worth while, he may bind a small wire round his foot, which must be convey'd under all his cloths and wrist-band, and terminate at the finger he employs in touching the person electrified.

EXPERIMENT XXXIII.

In a basin of water, as D fig. 5. plate 2. place a metal funnel with its rim

rim downwards, as B; and let the person at one end of a chain made up of any number, as in the XXIst. Experiment, put his finger into the water, as at C; then let him at the other extremity, who holds a charged phial in his disengag'd hand, touch the nose of the funnel with its hook, as at A; and they will all alike feel the convulsive shock, and that at least as sensibly as in any of the former experiments.

EXPERIMENT XXXIV.

But this effect may be convey'd to a surprising distance: Suppose a man were to hold a finger of one hand in the water, at one end of the canal in St. James's park, and in his other hand the end of the wire, which must be extended all along one side of the canal, and fastned to the coat of a charged phial at the other end, held by another man's hand.

Suppose

Suppose also a cork, with a nail thrust through it, floating in the canal near this last man, and that he touch'd the said nail with the hook of his phial; they wou'd both that instant feel a violent shock, the water between the finger at one end, and the cork at the other, serving to compleat the circuit, ever necessary in the discharge of the phial.

EXPERIMENT XXXV.

The electrical shock may be communicated to animals divers ways. Dr. *Le Monnier* fix'd at the extremity of a brass ruler two small birds, a sparrow and a chaffinch. This ruler had a handle or pedestal fasten'd to the middle of it, for the conveniency of holding it. When the phial had been sufficiently charg'd on the conductor, he applied the head of the sparrow to the suspended phial; and the head of the chaffinch to the conductor. The consequence

quence upon the first trial was, that they were both instantaneously struck lifeless as it were, and motionless, for a time only, and they recover'd some few minutes after ; but upon a second trial, the sparrow was struck dead, and upon examination, found livid without, as if kill'd with a flash of lightning, most of the blood-vessels within the body being burst by the shock ; The chaffinch reviv'd, as before.

It is observable, that animals shock'd in this manner, tho' they escape, yet they are generally struck blind, if the stroke be given about the head. If they are any thing large, as rats, kittens, &c. I usually let them hang, fasten'd by the tail, to the prime conductor : Then having charg'd a large coated phial fill'd with filings, and hung also on the conductor ; I grasp the body thereof with a pair of tongs, as in fig. 1. plate 2. and apply its knobb to the head or belly

belly of the animal, which generally kills it at once. Note, that the hair of animals approaching a good deal to the nature of the electrics *per se*, 'tis necessary to wet it before the operation, that the discharge may exert its full force.

Dogs &c. may be shock'd in a lesser degree, either by being held by the fore-legs between two of the company, one holding the phial, and the other touching the conductor; or else a single person may lay hold of the tail, and with his other hand apply the hook of the charged phial to the nose.

EXPERIMENT XXXVI.

If you would produce a representation of thunder accompanied with lightning, you may proceed thus. Hang a piece of gilt leather, about a yard long, cross the prime conductor, as at A. fig. 1. plate 2. hang also a large phial thereon,

thereon, capable of holding five or six pounds of filings, and coated; when this is well charg'd, which will require forty or more turns of the wheel, grasp it with a pair of tongs, as in the former experiment, and apply the knobb to the leather, about six inches below the conductor, upon which the leather will flash quite up to the conductor with a very vivid sparkling, and the noise will be like the discharge of a pocket-pistol, or rather the explosion of *pulvis fulminans*.

The like noise and flash may be produc'd, if you hold a fire shovel in your hand with the back of its pan upwards, and lay a piece of gilt leather thereon; then taking the bottom wire of the charg'd phial in the hand that holds the handle of the shovel, and the body of the phial in your other hand, dart the end of the hook against the leather.

H

Éx-

EXPERIMENT XXXVII.

To the bottom of a large phial fill'd with filings, hang three or four yards of jack-chain. Then suspend it by the hook on the tube, as at C. fig. 2. plate 1. and let it receive its full charge; which done, apply the loose end of the chain to the tube, as at D; and at the same time the explosion is heard, every link of the chain will emit a bright flash of fire; so that in the dark it will seem a chain of fire.

I proceed now from luciferous experiments to those of real ignition, or setting bodies actually on fire.

EXPERIMENT XXXVIII.

Having electrify'd an egg on the conductor, as in experiment XXIII.

Let

Let a non-electric person approach the lower end thereof with a little rectified spirit of wine warm'd in a spoon, and the instant that the snapp is heard, the spirit will kindle into a flame.

EXPERIMENT XXXIX.

Let a person electrify'd upon a pedestal, as in experiment X. hold a spoon or ladle with warm spirits in his hand ; and let another un-electric person offer to touch the surface thereof with the end of his finger, and the spirit will take fire : The same will happen, if the un-electric person holds the ladle, and he that is electris'd touches the spirit.

EXPERIMENT XL.

A small metalline bucket with its syphon being electrify'd on the conductor as in the VIIIth. Experiment ;

H 2

place

place a person on an electric pedestal, and let him receive on one hand the sprinklings of the electrify'd water from the syphon, and with a finger of his other hand, let him offer to touch the surface of warm spirits held in the hand of one standing on the ground, and he shall be able to set it on fire.

This is a very curious experiment and very entertaining, to see fire produc'd from the sprinkling of cold water alone, receiv'd at so great a distance from the electrify'd vessel and syphon from whence it issues. But what will be said, if it shall be made appear in the next experiment, (as it will be upon the authority of the skilful Mr. *Watson*) that spirit of wine may be fired by the most unlikely of all materials, real ice?

EXPERIMENT XLI.

From the affinity that ice has with water, Mr. *Watson* conjectur'd that it was endow'd with the same properties: Accordingly, upon electrifying it, he observ'd it to flash and snap upon the touch of a non-electric; and, held in the hand of an electrified man, fir'd warm spirits, chemical vegetable oils, &c. Care must be taken however, that the ice does not melt; for every drop from it carries off much of the electricity. On this account, he made his assistant, while he was electrifying, continually dry the ice with a napkin hung to his button, which being electrified as well as the ice prevented the loss of the force.

EXPERIMENT XLII.

The same ingenious gentleman, tho' he could fire spirits, as we have seen,
with

with ice ; yet could he never arrive to kindle so likely a substance as gunpowder by the electrical fire, unless it were mixt with some other matter, the fumes of which took fire first, and so kindled the powder : This he imputes in part from its vapours not being inflammable, and in part from its not being capable of being fir'd by flame, unless the sulphur in its composition is nearly in the state of accension.

But he cou'd fire gunpowder without difficulty by grinding it with a little camphire, or with a few drops of some inflammable chemical oil. The gunpowder then being warm'd in a spoon, the electrical flashes fired the inflammable vapour, and that in an instant the powder.

EXPERIMENT XLIII.

I shall take leave to add one more experiment of this gentleman's. He
put

put an ounce of oil of vitriol, an ounce of iron filings, and four ounces of water into a *Florence* flask; upon which an ebullition ensued, and upon the application of the finger of an electricity'd person to the mouth of the flask, the vapour took flame, and burnt out of the neck a considerable time.

This must be allowed a most curious experiment, to make a philosophical candle with three ingredients, neither of which will burn separately; and light it up in this manner. I have repeated it many a time myself; but would caution others against it, for fear of unlucky accidents. For sometimes the vapour, the instant it takes fire, will explode with a mighty noise, and burst the flask into a thousand pieces. Perhaps a small stone bottle, with a something wider neck, such as quicksilver is often kept in, might be more safely substituted in its stead.

Ex-

EXPERIMENT XLIV.

Lastly, I shall subjoin an experiment singular in its kind. It has been often, but in vain, attempted, to kindle substances by the electrical fire without warming them: But I have been so lucky to succeed therein upon one subject, and that is the urinous phosphorus, a production perhaps of a near nature to the electrical matter itself, which much resembles the burning fumes thereof both in colour and smell, as I have remark'd before. I held a bit of it cold, the bigness of a tare, in a pair of brass corn-tongs, and so applied it to the electrified conductor till snaps and sparks were produc'd, which presently kindled it, and it burnt with such violence as to melt away the points of the tongs that held it.

APPENDIX.

A P P E N D I X.

IN the distribution of the foregoing experiments, I endeavoured to range them, as much as might be with conveniency, under the heads of attraction and repulsion, the electrification of bodies supported by original electrics, animal sensations, light, and actual fire. Those which I here add, were communicated by Dr. *Bevis* since the former sheets were nearly printed off.

EXPERIMENT I.

A curtain-rod above six feet long,
and weighing near seven pounds,
laid upon a gun barrel suspended
on silk lines, and applied to a glass
I spheroid,

spheroid, as a conductor, was so poised that neither end preponderated. Then a fine flax thread of a foot long, with a small bit of swan's down at the end of it (both weighing less than half a grain) was so held in the hand, that as soon as the globe was in motion, the down was attracted by one end of the rod, but not suffered to touch it, and the thread thereby kept extended in an horizontal position, at right angles to the length of the rod, which soon began to approach the down; and upon the person's receding backwards that held it, kept following it, with an accelerated motion, through several feet of circular space. Yet, though the rod had thereby acquir'd a considerable velocity, upon the application of the down and thread, in a contrary direction, to the opposite side, its velocity was presently diminished, it stood still, and then moved again towards the down, the contrary way.

When

When a person, electrify'd on the stand, pointed the extremity of a finger towards the bar, it presently repell'd it.

But tho' so inconsiderable a body as a bit of down, was capable of imparting such a degree of motion to the rod; yet, which may seem very extraordinary, when a very large coated phial, fill'd with filings, was charg'd on the conductor, and a key at the end of its bottom wire applied to the end of the rod, in the same direction as the thread, so as that a great explosion and flash ensued, the rod was neither attracted, repell'd, or in the least agitated thereby.

The experiment with the down was afterwards repeated at Mr. *Watson's*, the bar being a spit near as heavy again as the curtain-rod, and flat; so that the friction must have been much greater; yet it succeeded very well.

EXPERIMENT II.

The phial mention'd in the last experiment, was hung, as before, on the same gun barrel : As soon as the spheroid began to turn, the down was briskly attracted, but the thread, though stretch'd, kept it about an inch from the barrel. The thread and feather continued in their vertical position, not only whilst the spheroid kept moving, but an hour and five and fifty minutes after it was stop'd ; the phial all this time supplying the vertue wherewith it had been charg'd. It should be noted besides, that though there was a brisk breeze of wind, and the windows open, yet these circumstances did not occasion any disturbance in the fibres of the down, nor the least deflection of the thread from the barrel ; and that probably the whole phænomenon would have lasted considerably longer, but that the chair was taken away unawares.

Ex-

EXPERIMENT III.

A phial of water being charg'd on the conductor, and then taken off, and the water poured into a basin of water unelectrified, the stream was luminous, as also was the surface of the water in the basin, till good part of the water was poured out of the phial. The like happened upon pouring iron filings from a charged phial, upon an unelectrify'd plate of metal.

Note, That if the phial, whether filled with filings or water, be coated, and the operator holds the plate or basin in his other hand, then the circuit before spoken of will be compleated by the stream of water or filings, and he will be shock'd in both elbows.

Ex-

EXPERIMENT IV.

The former led the way to this experiment, which is curious and very entertaining.

A person was placed on an electric stand, holding in one hand a ladle with warm spirit of wine, and extending the other hand; into the palm of which, when another person poured the water fully charged with the electric matter in a phial, a third person, standing on the floor, at the same time approached his finger to the spirit, and very readily set it o'fire.

EXPERIMENT V.

If a fresh red rose be held within an inch of that end of the conductor which is remote from the globe, so as to receive the issuing electrical

trical matter, which in the dark shows itself in the form of a blue brushy flame, it will in a few minutes lose its lively colour, and turn pale; and if set aside some hours, will be withered, dry, and yellow, as if burnt up by the heat of a fire.

EXPERIMENT VI.

Let the rubber be taken away from the globe, and let a man placed upon an electric stand, endeavour to excite electricity in the globe by the friction of his hands alone, nothing else being in contact with, or approaching near the surface of the globe. Then, if another man, standing on the floor, applies his finger to him on the stand, he will seem entirely unelectrified, for no snapping will be perceived. But, all things remaining the same, let the prime conductor, a gun barrel for instance, suspended on silk lines, touch
or

or approach the globe ; and then, upon an application of the finger, as before, there will be a very perceptible snapping.

The gentleman who imparts this experiment, would not have it considered as his own. He observes, that being mentioned to him by a * friend, it surpriz'd him ; but finding it to answer upon trial, he look'd upon it as a decisive proof, that the electric matter is, contrary to a receiv'd opinion, derivable from the air : For here the barrel is in contact with no non-electric that has communication with the ground ; and 'tis well known, that dry silk lines are never a vehicle of electricity. Whence therefore can it any way be imparted to the man on the stand, but from the air, by means of the barrel ?

* Mr. *Felix Clay*.

This notion moreover he embraced with less scruple, as he found several gentlemen of the *Royal Society*, to whom he shewed the experiment, concur with him: Yet, from a hint of Mr. *Watson's*, that there might be something statical in it, he is now rather inclined to think that these phenomena may be better explained by supposing, that no snapping is produced between two bodies in each of which the electric vertue is as its respective quantity of matter; but that when it is otherwise, they snap upon a near approach to each other.

In the experiment, the man on the stand, and he on the ground, have each a like degree of the electric vertue; that is, their natural quantity: Nor can the globe take away any from him that gives it friction with his hands, because it has no non-electric, insulated or otherwise, to bestow it upon; so no snapping can be produced between these persons. But

as soon as the barrel, an insulated non-electric, is brought to it, part of the virtue is pump'd from the man, and accumulated in the barrel. And now, the quantities being dissimilar in the two persons, they will snap, and by the snapping, the equilibrium will be restored between them. This, the Doctor observes, seems to be more confirmed by pursuing the experiment a little farther, thus: Let the non-electric person touch the barrel, and the like snap is produced as when he touched the man on the stand: But if he on the stand presses the globe with one hand, and touches the barrel with the other, a much louder snap will be heard.

The snap between the two persons is from the excess of the virtue in him on the ground, above that in him on the stand: But the snap between him on the stand and the barrel, is from the excess of the virtue in the barrel (being more than the natural quantity) above
 that

that in this man (being less than the natural quantity). Whence the snap, in restoring the equilibrium, must necessarily be greater here than in the former case.

Advertisement.

MACHINES for performing all manner of electrical experiments, made and sold by *John Neale* at his house in *Leaden-hall-street*, executed in the best manner, according to the designs of those who bespeak them, with the apparatus proper to accompany them, as also variety of Orreries with new improvements, under his Majesty's patent, and his perambulator, for readily measuring and surveying land.

The portable electrical machine, which for its commodious package and easy performance, has met with a general approbation, is of the following construction.

IN plate 3. fig. 1. A represents a glass matras or decanter, about seven or eight inches diameter, pretty thick and strong; B, a hollow metal cylinder, very truly turned, for receiving the neck of the glass, fastened into it with cement; D D D D, the frame it runs in; E, the grooved pulley that receives the cat-gut string, whose section is shewn at E, fig. 6. G, in same figure, representing the great wheel that turns the glass on its cylindrical axis, by means of a handle at C, represented with the pin on which it turns, and the fastening skrew at fig. 7.

Fig 2. represents the square-board to which both the wheel and frame are fixed. It has folding joints at A A, for saving room in the packing case. B and C are square holes; B to receive the lower end of the skrew F, fig. 1, on whose upper end the point of the cylinder bears, its frame being fastened down by skrews to the board at D D. The hole C is to receive the tail of the wheel-pin represented by fig. 5. which is pinched fast by a female skrew bearing against the underside of the board, so as not to stir when the string is sufficiently stretch'd, to admit of which the whole is made oblong.

Fig. 4. represents a frame for receiving a globe or spheroid with pivots at the extremities of its axis, which by means of an elbow and pinch-screws, as at B, may be fastened, either to the square board, fig. 2. or to one end of a table, the wheel turning on its pin, fixed by a like elbow and screw, to the other end of the board or table; which makes it rather more simple and universal than the other construction, as appears from fig. 5. plate 1.

In either, the wheel being in motion, the electrical vertue is excited by giving friction to the glass, either with a dry hand, or, which is less inconvenient, by the pressure of a leather cushion, as I. fig. 1. fixed to the end of a spring K.

(77)

To the PUBLICK.

WHereas from several late instances of the success of electrical applications to persons afflicted with nervous disorders, especially of the paralytic kind, it appears highly probable, that great benefit may accrue from thence to the community; and that it will be well worth while to determine further by experience in what particular cases success may be expected, or despaired of; it is earnestly requested of all those who have made or undergone any such trials, that they would be pleased to transmit circumstantial and well attested accounts thereof, either to *John Neale*, at his house in *Leaden-ball-street*, or to *Mr. Watkins*, at *Sir Isaac Newton's Head, Charing-cross*, to be inserted in a narrative in due time to be published, of the success of electrifying in the aforesaid disorders.

E R R A T A.

Page 47. line 20. for there of, read thereof; pag. 47. line 23. for XXIII, read XXIV. line 24. stricks out XXVII.

Fig. 1.



Plate

A

Fig. 2.

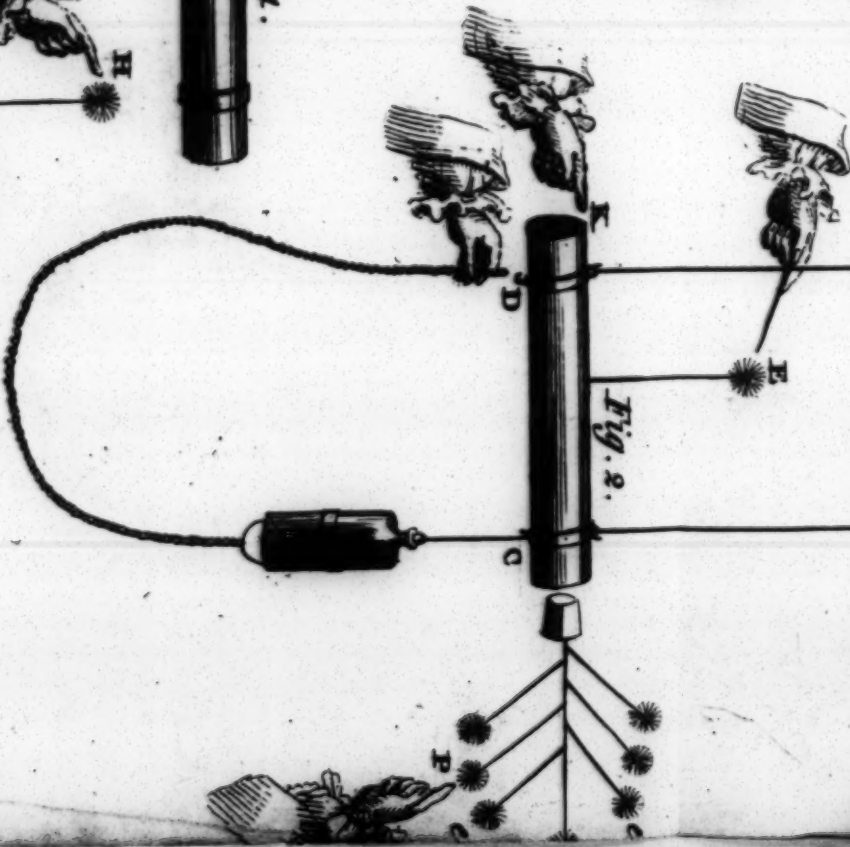


Fig. 3.

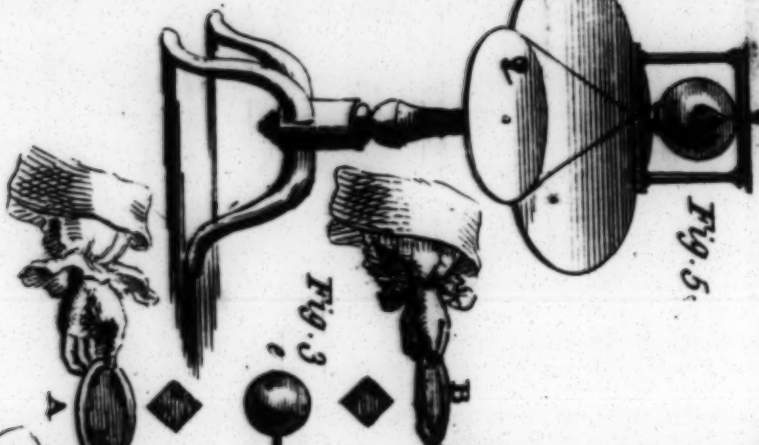


Fig. 4.

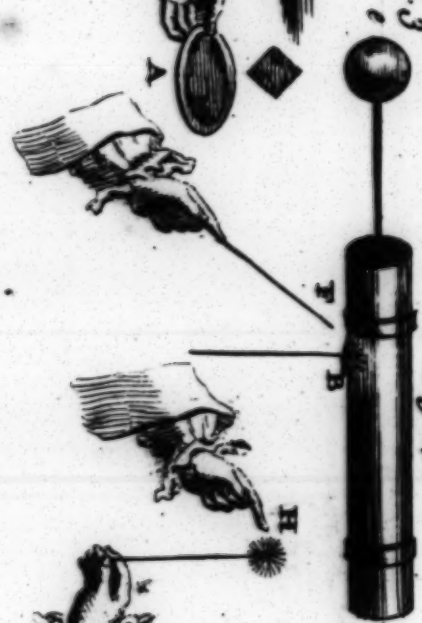
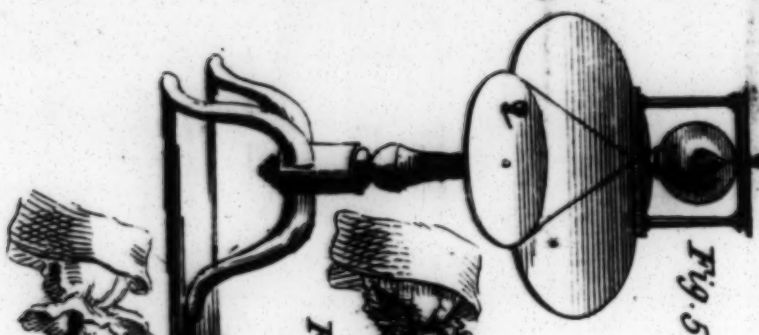
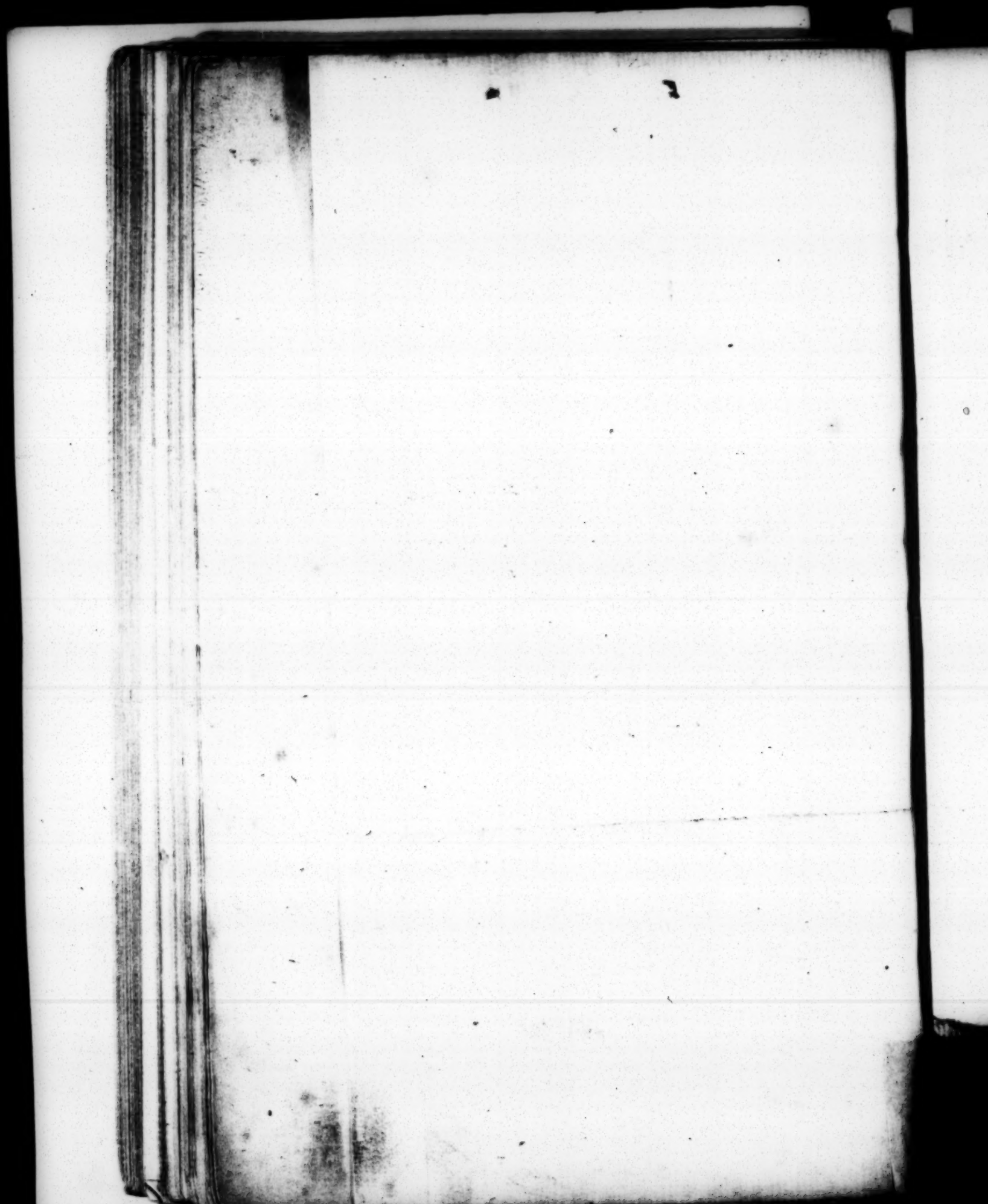


Fig. 5.





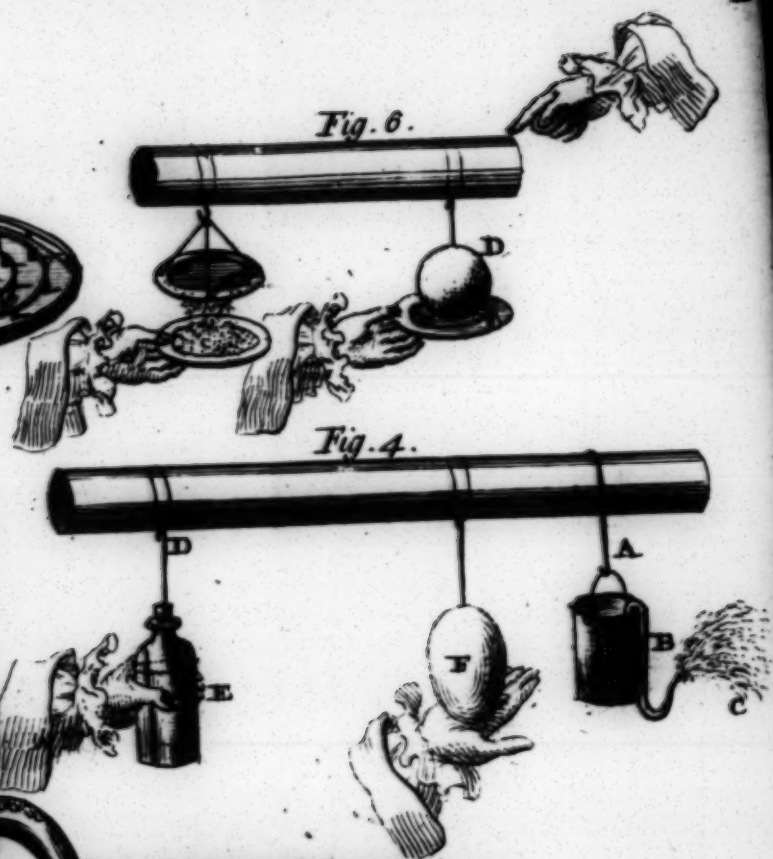
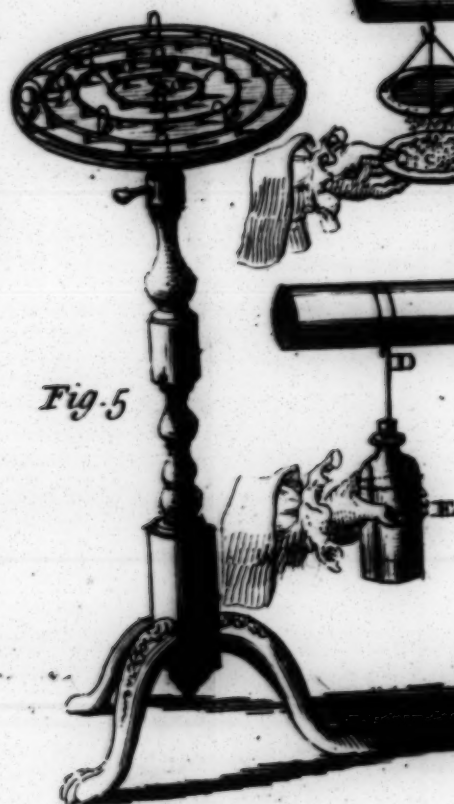
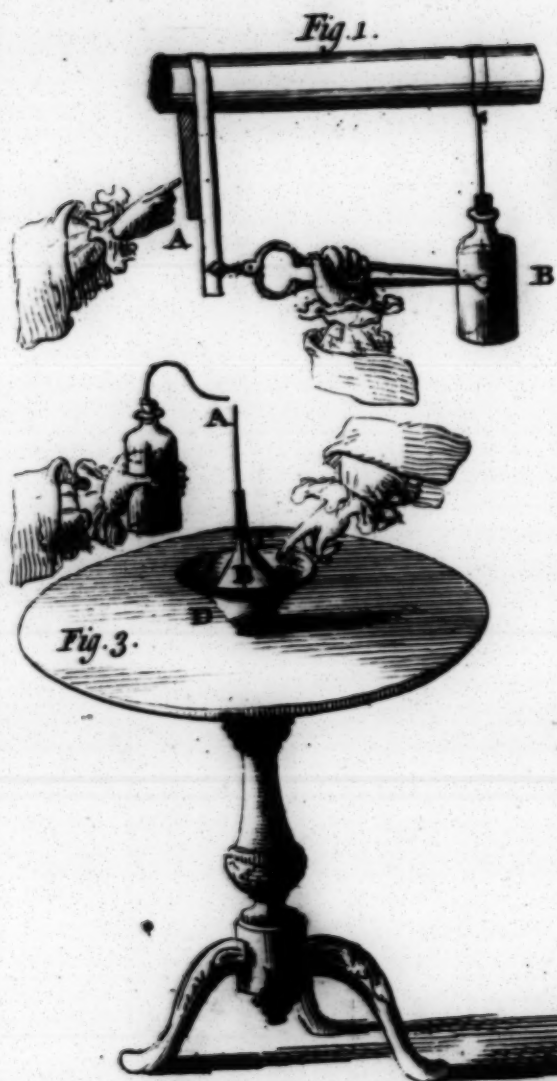






Fig 4.



Fig 3.

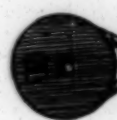
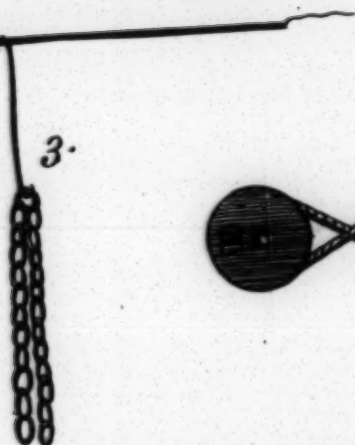


Fig 6

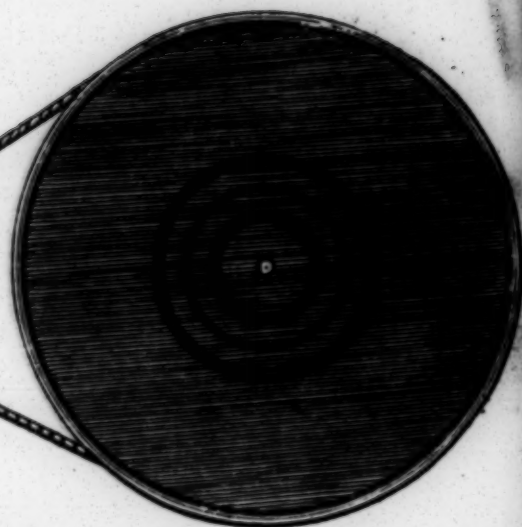


Fig 5

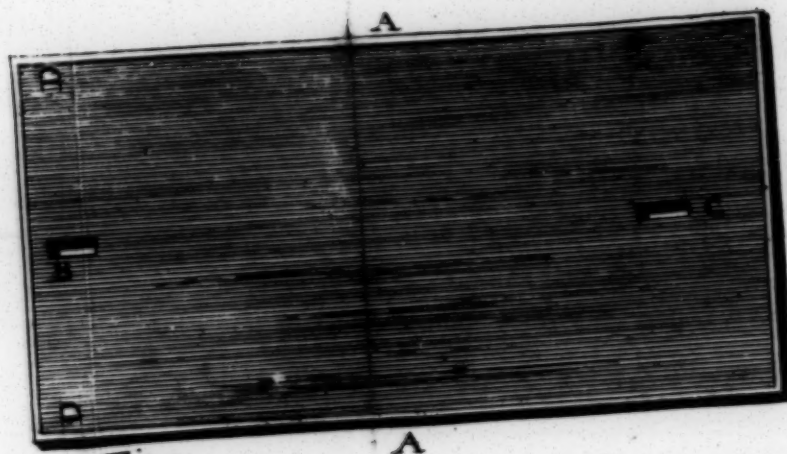
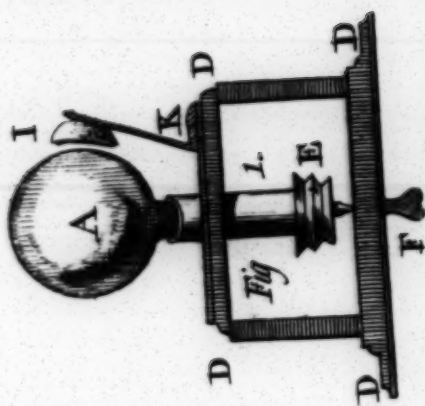


Fig 2